REMARKS

I. Introduction

By the present Amendment, claims 6, 7, 10, and 12 have been amended. Claims 3, 4, 11, 13-21, 23, and 24 have been cancelled. Claims 26-30 are newly presented for consideration. Accordingly, claims 5-7, 10, 12, 22, and 25-30 remain pending in the application. Claims 6, 27, and 30 are independent.

II. Office Action Summary

In the Office Action of July 25, 2008, claims 1-12, and 20-22 were rejected under 35 USC §103(a) as being unpatentable over U.S. Patent No. 6,980,846 issued to Hardy et al. ("Hardy") in view of U.S. Patent No. 5,479,537 issued to Hamashima. Claims 13-19 and 23 were rejected under 35 USC §103(a) as being unpatentable over Hardy in view of Hamashima, and further in view of U.S. Patent No. 5,668,474 issued to Heid. The cancellation of claims 1, 2, 8, 16, and 18-21 (in the Amendment filed November 25, 2008) and claims 3, 4, 11, 13-21, 23, and 24 has rendered some of these grounds of rejection moot. Regarding the remaining claims, these rejections are respectfully traversed.

III. Interview

Applicants would like to thank Examiner's Cheng and Le for the courtesy and cooperation extended during the interview conducted March 4, 2009. During the interview, Applicants discussed operation of the claimed invention and the features that were not believed to be disclosed by the cited references. In particular, Applicants noted that the cited references failed to provide any disclosure for application of a second pulse sequence, and reconstructing the image using nuclear

magnetic resonance signals collected from the second pulse sequences. The Examiner indicated that such features were not clearly recited in the present claims. Applicants agreed that the claims would be amended and/or rewritten to better clarify these features and submitted as part of a Supplemental Amendment.

IV. Rejections under 35 USC §103

Claims 1-12, and 20-22 were rejected under 35 USC §103(a) as being unpatentable over Hardy in view of Hamashima. Regarding this rejection, the Office Action indicates that Hardy discloses a method for acquiring image data from a subject with an MRI system, and that the MRI system acquires a reference data set of a region of interest, such as the motion of the heart or the heartbeat, and then acquires a plurality of free-breathing data sets of this region of interest. The free-breathing data sets are then compared with the reference data to be used in creating an image of the region of interest. The Office Action also indicates that it is well known in the art that an MRI system inherently comprises an RF coil for generating an RF magnetic field, a main static magnet providing a static magnetic field, gradient coils to generate the magnetic field gradients, and a controller to control the pulse sequences. The Office Action indicates that Hardy discloses a reference data set being taken during a single breath-held time period, and that the comparison between the reference and free-breathing images are done through cross-correlations to decide which images should be kept and which should be thrown away. If the feature of interest is present in any of the free-breathing images, then the cross-correlation will reveal a strong central peak, otherwise, the central peak will be offset. The Office Action indicates that Hardy does not expressly disclose setting a threshold to determine which images to reject. Nonetheless, it is presumed that

some sort of threshold can be set in the form of L/M away from the L, with M being greater than two. The Office Action further indicates that the comparison is not by using a similarity coefficient, but that it would be obvious to use any sort of comparison method to obtain the proper images. The Office Action specifically points to Hamashima, which discloses an image comparison method that uses cross-correlation and threshold cut-off values to determine if an image matches a reference image. Regarding the controller, the Office Action indicates that any controller has the ability to create a desired sequence of pulses wanted. Applicants respectfully disagree.

By the present Amendment, Applicants have further revised the language of independent claim 6 to better clarify the invention and for consistency with the features discussed during the interview. As amended, independent claim 6 defines an inspection apparatus using nuclear magnetic resonance that comprises:

> a controller for controlling a pulse sequence which applies a radiofrequency magnetic field and a magnetic field gradient to a living body placed in a static magnetic field to detect a nuclear magnetic resonance signal produced from said living body; and
>
> an arithmetic processor for performing an image reconstruction of an imaging section using said detected nuclear magnetic resonance signal,
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> wherein said controller is configured to:
>
> (1) control application of a first pulse sequence detecting said nuclear magnetic resonance signal when said living body stops exhalation or inhalation;
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> (2) control application of said first pulse sequence once in a state that said living body breathes; and
>
> (3) control of repeated application of a second pulse sequence for detecting said nuclear magnetic resonance signal at predetermined repetition time intervals,
>
> wherein said arithmetic processor is configured to:
>
> (a) perform arithmetic processing of acquiring a reference projection of said imaging section from said nuclear magnetic

resonance signal detected in said first pulse sequence when said living body stops exhalation or inhalation;

(b) perform arithmetic processing of acquiring a projection of said imaging section from said nuclear magnetic resonance signal detected in said first pulse sequence when said living body breathes; and

(c) perform arithmetic processing of determining a similarity coefficient between said projection and said reference projection, said similarity coefficient being scalar,

wherein said controller is further configured to (4) collect or discard said nuclear magnetic resonance signals from said second pulse sequence based on said similarity coefficient, and reconstructing said image using the collected nuclear magnetic resonance signals, and

wherein said projection is one-dimensional, and said reference projection is one-dimensional.

According to the inspection apparatus of independent claim 6, a controller is provided for controlling a pulse sequence which applies a radio frequency magnetic field and a magnetic field gradient to a living body placed in a static magnetic field to detect a nuclear magnetic resonance signal produced by the living body. An arithmetic processor is provided for performing an image reconstruction of an imaging section using the detected nuclear magnetic resonance signal. The controller controls application of a first pulse sequence to detect the nuclear magnetic resonance signal when the living body stops exhaling or inhaling (i.e., during a breath-holding period), and controls application of the first pulse sequence once when the body is breathing. Additionally, the controller controls repeated application of a second pulse sequence to detect nuclear magnetic resonance signals at predetermined repetition time intervals.

The arithmetic processor performs arithmetic processing to acquire a reference projection of the imaging section from the nuclear magnetic resonance signal detected based on the first pulse sequence when the body is not exhaling or

inhaling, and performs arithmetic processing to acquire a projection of the imaging section from the nuclear magnetic resonance signal detected in the first pulse sequence while breathing. The reference projection and the projection are both one-dimensional. Additionally, the arithmetic processor determines a similarity coefficient (which is a scalar) between the projection and the reference projection. According to independent claim 6, the controller also determines whether to collect or discard the nuclear magnetic resonance signals from the second pulse sequence based on the similarity coefficient, and reconstructs the image using the nuclear magnetic resonance signals that have been collected.

The Office Action indicates that the combination of Hardy and Hamashima discloses all of the features recited in independent claim 6. This does not appear to be the case. Contrary to the claimed invention, Hardy relates to an ECG-gated fat-suppressed multi-sliced spiral imaging technique which synchronizes with an electrocardiogram. See column 3, lines 22-32. Consequently, Hardy never considers, or accounts for, the influences of the heartbeat on the reference image.

As discussed during the interview, Hardy never applies a second pulse sequence. Rather, Hardy utilizes a single pulse sequence that is applied during a breath holding period and a breathing period. A reference image obtained during application of the pulse sequence with breath-holding is compared to an image obtained from application of the pulse sequence with breathing. Based on this comparison, images matching the reference image are selected, and the selected images are combined to form the final averaged image of the region of interest (ROI). See Figs. 3 and 4 and corresponding text. Hardy also does not determine a similarity coefficient between application of the first pulse sequence when breathing

and breath holding. Rather, each image obtained while breathing is compared to the corresponding image obtained while breath-holding.

Applicants further note that the present invention reconstructs the image using nuclear magnetic resonance signals resulting from application of the second pulse sequence. More particularly, nuclear magnetic resonance signals from the second pulse sequence are collected or discarded based on the similarity coefficient. The image is then reconstructed using the collected signals. According to independent claim 6, the similarity coefficient is determined between the projection and the reference projection. This greatly reduces the time and computational load required. Furthermore, the same similarity coefficient is used to collect or discard nuclear magnetic resonance signals from second pulse sequence. This further reduces the complications associated with reconstructing the image because a new similarity coefficient does not have to be calculated for each projection based on new comparisons as disclosed by Hardy.

Applicants further note that Hamashima discloses the image to be compared being cut from the input image, and the reference image being passed through different filters. There is no disclosure or suggestion for applying a second pulse sequence or reconstructing the image using collected nuclear magnetic resonance signals resulting from application of the second pulse sequence. The art of record simply fails to provide any disclosure or suggestion for features recited in independent claim 6, such as:

> wherein said arithmetic processor is configured to:
>
> (a) perform arithmetic processing of acquiring a reference projection of said imaging section from said nuclear magnetic resonance signal detected in said first pulse sequence when said living body stops exhalation or inhalation;

(b) perform arithmetic processing of acquiring a projection of said imaging section from said nuclear magnetic resonance signal detected in said first pulse sequence when said living body breathes; and

(c) perform arithmetic processing of determining a similarity coefficient between said projection and said reference projection, said similarity coefficient being scalar,

wherein said controller is further configured to (4) collect or discard said nuclear magnetic resonance signals from said second pulse sequence based on said similarity coefficient, and reconstructing said image using the collected nuclear magnetic resonance signals, and

It is therefore respectfully submitted that independent claim 6 is allowable over the art of record.

Claims 5, 7, 10, 12, 22, 25, and 26 depend from independent claim 6, and are therefore believed allowable for at least the reasons set forth above with respect to independent claim 6. In addition, these claims each introduce novel elements that independently render them patentable over the art of record.

By the present Amendment, Applicants have introduced independent claims 27 and 30 for consideration. Independent claim 27 defines an inspection apparatus using nuclear magnetic resonance that comprises:

a controller for controlling a pulse sequence which applies a radiofrequency magnetic field and a magnetic field gradient to a living body placed in a static magnetic field in order to detect a nuclear magnetic resonance signal produced from said living; and

an arithmetic processor for performing an image reconstruction of an imaging section using said detected nuclear magnetic resonance signal;

wherein said controller is configured to:

apply a first pulse sequence, during a breath-holding period, to determine a reference nuclear magnetic resonance signal,

apply the first pulse sequence, while breathing, to determine a first nuclear magnetic resonance signal,

apply a second pulse sequence a predetermined number of times, while breathing, to determine a plurality of second nuclear magnetic resonance signals, and

repeat application of the first pulse sequence while breathing and application of the second pulse sequence for a predetermined length of time, and

wherein said arithmetic processor is configured to:

determine a reference signal corresponding to application of the first pulse sequence during the breath-holding period,

determine a first signal corresponding to each application of the first pulse sequence while breathing,

determine a plurality of second signals corresponding to each application of the second pulse sequence a predetermined number of times,

compare each second signal to the reference signal,

determine a similarity coefficient for each second signal based on comparison to the reference signal,

save or discard second nuclear magnetic resonance signals based on a corresponding similarity coefficient, and

reconstruct the image using the saved second nuclear magnetic resonance signals and the first nuclear magnetic resonance signals.

The inspection apparatus of independent claim 27 recites various features that are similar to those recited in independent claim 6. For example, a first pulse sequence is applied during a breath-holding period and during a breathing period. Next, a second pulse sequence is applied while breathing. As previously discussed, such features are not shown or suggested by the art of record.

Furthermore, according to independent claim 27, the first pulse sequence and the second pulse sequence are repeatedly applied while breathing in order to determine a first signal and a plurality of second signals, respectively. The nuclear magnetic resonance signals from the second pulse sequence are saved or discarded based on comparison with the similarity coefficients. The image is subsequently reconstructed based on the first nuclear magnetic resonance signals and the saved

second nuclear magnetic resonance signals. Such features are also not shown or suggested by the art of record.

It is therefore respectfully submitted that independent claim 27 is allowable over the art of record.

Claims 28 and 29 depend from independent claim 27, and are therefore believed allowable for at least the reasons set forth above with respect to independent claim 27. In addition, these claims each introduce novel elements that independently render them patentable over the art of record.

Independent clam 30 defines a method of creating images of an imaging section using nuclear magnetic resonance that comprises the steps of:

> applying a first pulse sequence, during a breath-holding period, to determine a reference nuclear magnetic resonance signal,
>
> applying the first pulse sequence, while breathing, to determine a first nuclear magnetic resonance signal,
>
> applying a second pulse sequence a predetermined number of times, while breathing, to determine a plurality of second nuclear magnetic resonance signals;
>
> repeating the steps of applying the first pulse sequence while breathing and applying the second pulse sequence for a predetermined length of time;
>
> determining a reference signal corresponding to the first pulse sequence applied during the breath-holding period;
>
> determining a first signal corresponding to each of the first pulse sequences applied while breathing;
>
> determining a plurality of second signals corresponding to each of the second pulse sequences applied a predetermined number of times;
>
> comparing each second signal to the reference signal;
>
> determining a similarity coefficient for each second signal based on the step of comparing;
>
> saving or discarding second nuclear magnetic resonance signals based on a corresponding similarity coefficient; and

reconstructing the image using the saved second nuclear magnetic resonance signals and the first nuclear magnetic resonance signals.

The method of independent claim 30 recites steps which correspond somewhat to operation of the elements recited in independent claim 27. Accordingly, independent claim 30 is believed to be allowable over the art of record.

V. Conclusion

For the reasons stated above, it is respectfully submitted that all of the pending claims are now in condition for allowance. Therefore, the issuance of a Notice of Allowance is believed in order, and courteously solicited.

If the Examiner believes that there are any matters which can be resolved by way of either a personal or telephone interview, the Examiner is invited to contact Applicants' undersigned attorney at the number indicated below.

AUTHORIZATION

Applicants request any shortage or excess in fees in connection with the filing of this paper, including extension of time fees, and for which no other form of payment is offered, be charged or credited to Deposit Account No. 01-2135 (Case: 520.42912X00).

Respectfully submitted,
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